Evaluating the Effectiveness of Red Light Running Camera Systems

Kim Eccles, P.E.
VHB, Raleigh, NC

Based on work with

Dr. Forrest Council, Dr. Bhagwant Persaud, Michael Griffith, Craig Lyon, Dr. Hugh W. McGee, and others

TRAFFIC ENGINEERING CONFERENCE FOR OPERATIONS AND SAFETY
August 23-25, 2006

VHB

Overview of Presentation

- Background on the Problem
- Other Studies
- FHWA National Evaluation
  - Overview of methodology
  - Overview of results
- Available Guidance Materials

National Red Light Running Problem

- Preliminary estimates for 2003 indicate 206,000 crashes, 176,000 injuries, and about **934 deaths** were attributed to red light running

International and National Studies

- Red light camera (RLC) systems proposed as an countermeasure
- Numerous studies have been conducted to determine camera effectiveness
  - Great Britain
  - Singapore
  - Australia
  - Oxnard, San Diego, and San Francisco, CA
  - Polk County, FL
  - Mesa, AZ

Conducting an Evaluation: MOEs

- Previous studies mentioned have used various measures of effectiveness
  - Red light violations
  - Traffic conflicts or near misses
  - Crashes (preferred)

Motivation for National Study

- Lack of definitive evidence on effect of RLC systems on crashes due to methodology problems in past studies
- Need to combine opposing effects on angle and rear-end crashes (which are of differing severities)
- Need for multi-jurisdictional study using consistent methodology

FHWA National Evaluation

- National Red Light Running Camera Systems Study
- Sponsored by the FHWA's Joint Programs Office and Office of Safety Research and Development
- Before and After Empirical Bayesian (EB) Study

FHWA National Evaluation

- Includes data from seven jurisdictions around the nation
- Safety effects measured in terms of crashes, not changes in violations
- Study began in 2001

VHB

Overview of Methodology

- Identified sample metropolitan areas where RLCs had been deployed
- Collected crash, volume, geometry, and signal timing data
- Collected data before and after cameras were installed

Overview of Methodology

- Three groups of intersections in each jurisdiction
  - Signalized treatment intersections (equipped with cameras)
  - Signalized reference intersections (no cameras)
  - Unsignalized reference intersections (i.e., stop-controlled intersections)

Overview of Methodology

- Used the state of the art methods to estimate changes in right angle and rear end crashes following RLC installation
- Developed and applied unit economic crash costs to “translate” changes in crashes to a net change in total crash costs
- Identified factors contributing to RLC effectiveness to develop guidelines for selecting intersections for RLC deployment

Empirical Bayes Methodology

- Compares crashes in “after” period to an estimate of what would have occurred without RLC (*B*).
- *B* is a weighted average of the crash counts in the “before period” and the number of crashes expected to occur at similar sites (*P*).
- *P* is estimated from a safety performance function that links crashes to traffic volumes and site characteristics.

Safety performance function for Charlotte for 4-legged signalized

$$\text{Crashes/year} = 0.045 \times (\text{major AADT})^{0.37} \times (\text{minor AADT})^{0.14} \times \exp(0.264 \times \#\text{ of left lanes on major})$$

Study Jurisdictions

Jurisdiction	Treated Sites	Signalized	Unsignalized
Baltimore	19	86	46
Charlotte	**31**	**74**	**42**
El Cajon	6	53	38
Howard County	18	34	38
Montgomery Co.	21	55	40
San Diego	19	54	44
San Francisco	18	52	48
Total	132	408	296

Combined Results

Combined Results for the Seven Jurisdictions	Right Angle		Rear-end	
	Total	Injury	Total	Injury
EB Estimate of Crashes Expected in After Period w/o RLC	1542	351	2521	131
Count of Crashes Observed in the After Period	1163	296	2896	163
Estimate of Percent Change	-24.6	-15.7	14.9	24.0
Estimate of the Change in Crash Frequency	-379	-55	375	32

Individual Results

Jurisdiction Number	Change in Right-angle	Change in Rear-end
1	-40.0%	21.3
2	0.8%	8.5%
3	-14.3%	15.1%
4	-24.7%	19.7%
5	-34.3%	38.1%
6	-26.1%	12.7%
7	-24.4%	7.0%

Spillover Results

- Attempted to quantify spillover at nearby intersections
  - Modest decrease in right angle crashes
  - Negligible increase in rear-end crashes
- Conclusion: Further study needed

VHB

Economic Analysis: Fundamental Issues

- Does the increase in rear-end crashes negate the benefits for right-angle crashes?
  - 25% decrease for total right-angle
  - 16% decrease for injury right-angle
  - 15% increase for total rear-end
  - 24% increase for injury rear-end
- Since angles and rear-ends are different severities, must combine using economic costs

Economic Analysis

- Required estimates of *comprehensive cost per crash* for angle, rear-end and other crash types by severity level
- New (2001) crash cost estimates developed
  - Used NASS-CDS and GES data
  - Converted *cost per victim* to *cost per crash* for 21 crash types and KABCO severities
- Cost per crash was then used in EB methodology to estimate overall economic effect of RLC

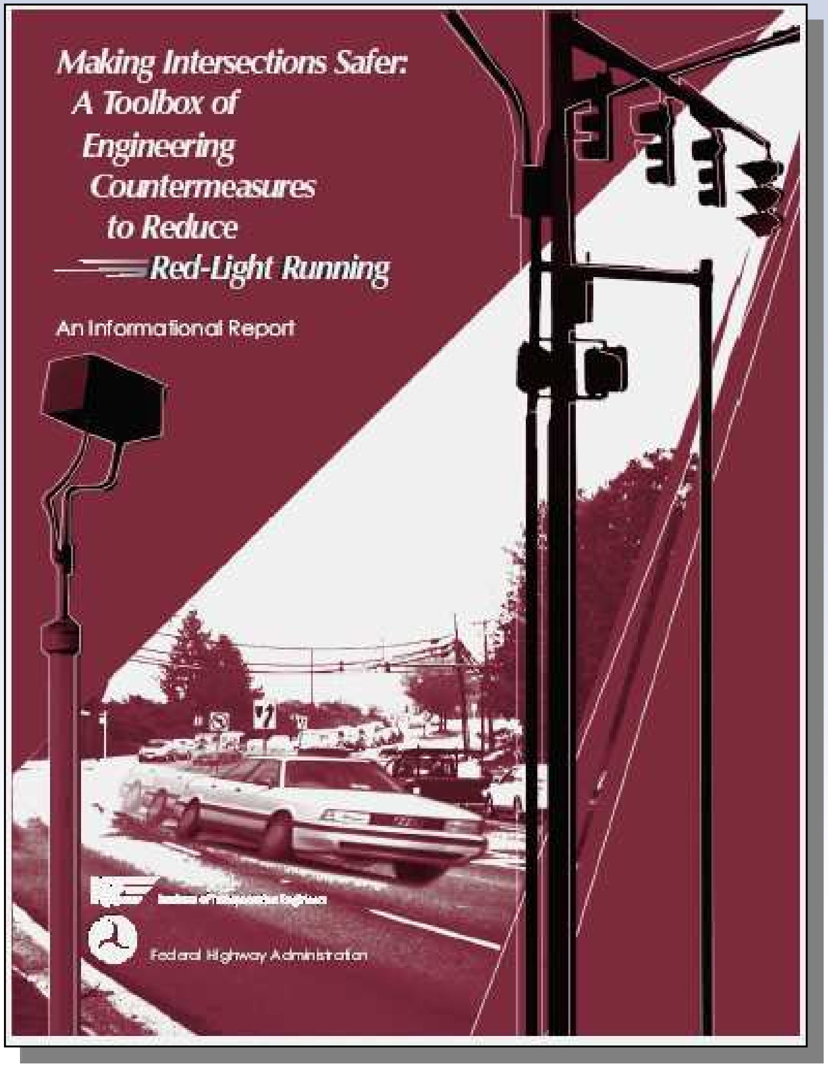
Economic Effects

	All severities combined	PDOs excluded
Overall crash cost decrease	$14,372,471	$18,505,419
Cost decrease per site year	$38,845	$50,015

Greatest Economic Benefits: Factors

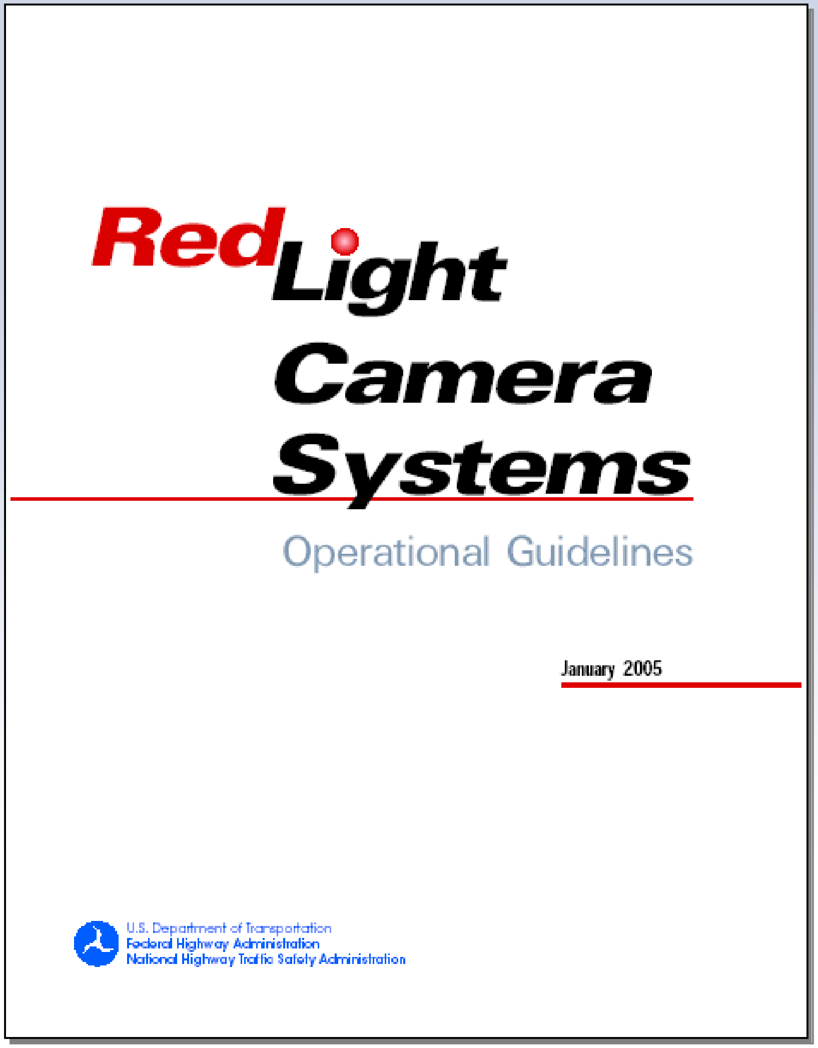
- Higher ratios of right-angle to rear-end
- Higher proportions of entering volume on the major road
- One or more left turn protected phases
- Higher entering volume
- Warning signs at both RLC intersections and city limits
- High publicity level

Making Intersections Safer Toolbox



- Released by FHWA and ITE in 2003
- Provides information to proactively discourage red-light running
- Identifies engineering features to consider

FHWA RLC Operational Guidelines


Red Light Camera Systems

Operational Guidelines

January 2005

U.S. Department of Transportation
Federal Highway Administration
National Highway Traffic Safety Administration

- FHWA update to March 2003 document
- Provides information on
  - Understanding of the problem
  - Problem identification
  - Countermeasures and their application
  - RLC program implementation

For More Information, Please Contact

Kim Eccles at VHB

keccles@vhb.com

EB Method for Economic Costs

- Involved two severity categories for each crash types – injury vs. non-injury
- “Expected crashes without treatment” generated with EB methodology for
  - injury and non-injury and for,
  - angle, rear-end, other

VHB

EB Method for Economic Costs

- "Expected without treatment costs" = expected frequency × cost per crash
- "Observed with-treatment costs" = observed frequencies × cost per crash
- "Expected without treatment costs" compared to "observed with-treatment costs" -- then aggregated across all crash severities, crash types, and sites

Comprehensive crash cost estimates for urban signalized intersections

Crash Severity Level	Angle Crash Cost	Rear-end Crash Cost
K	$4,090,042	$3,781,989
A	$120,810	$84,820
B	$103,468	$27,043
C	$34,690	$49,746
O	$8,673	$11,463
K+A+B+C "injury crash"	$64,468	$53,659